1996
HABITAT AND AQUATIC MACROINVERTEBRATE SURVEY

STREAMS OF THE NEVADA CREEK DRAINAGE, POWELL COUNTY, MONTANA

prepared for
Deer Lodge Valley Conservation District
and
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prepared by
Wease A Bollman
Aquatic Ecologist
Missoula, Montana

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Introduction

Aquatic macroinvertebrate and habitat surveys were conducted in streams of the Nevada Creek drainage in June, 1994 to establish baseline biotic conditions. Best Management Practices were subsequently implemented for the purpose of reducing erosion and sedimentation in the watershed. Follow-up surveys were then conducted at the same sites in the drainage in June, 1996 in order to measure, in part, the success of the implementation. This report presents the data from the 1996 surveys, evaluates the findings, and compares biotic and habitat conditions in the various sites as indicated in the 1994 analysis and 1996 data.

Methods

Benthic macroinvertebrate sampling was performed by personnel of the Montana Department of Environmental Quality (DEQ) on June 26, 1996. The traveling kick-net method described by Bukantis (1996) was utilized. Two samples were collected from each of five riffled reaches; the resulting ten samples were numbered and sites described as follows:

1.1 and 1.2 from Nevada Creek at the Stucky Ranch
2.1 and 2.2 from Washington Creek at the Stucky Ranch
3.1 and 3.2 from Nevada Creek at the Nevada Creek Ranch
4.1 and 4.2 from Jefferson Creek at the F.Mannix Ranch
5.1 and 5.2 from Nevada Creek at the F.Mannix Ranch.

Habitat parameters were scored using a DEQ-modified version of the US EPA Rapid Bioassessment Protocols (RBP) (Plafkin et al. 1989).

In the laboratory, the RBP III sorting method was used to obtain subsamples of approximately 300-350 organisms from each of the ten samples. The organisms were identified to taxonomic levels appropriate to RBP III analysis, usually genus or species. Guidelines for taxonomic work provided by Bukantis (1996) were followed. Community structure, function and sensitivity to impact were characterized for each subsample using the battery of eight metrics recommended by DEQ for Montana Valley and Foothill Prairie streams, and used by McGuire (1995) in his earlier report on data from the same streams. An internal reference approach was used exclusively in this analysis: a reference value for each metric was established for all study sites based on the performance of that metric at all sites in both years studied. The best value in either of the two years' data on Nevada Creek drainage streams was chosen as the point of comparison, or reference value, for each metric used.

Actual metric values for the two samples taken at each site were averaged and the mean value was compared to the reference values to obtain metric scores. Total metric scores were obtained by summing scores for all metrics, and an impairment classification for each site was derived from this total score. For purposes of comparison, the data from the 1994 study were recalculated using the updated internal reference values, resulting in changes to impairment classifications assigned in 1994. The changes are summarized in Table 3.

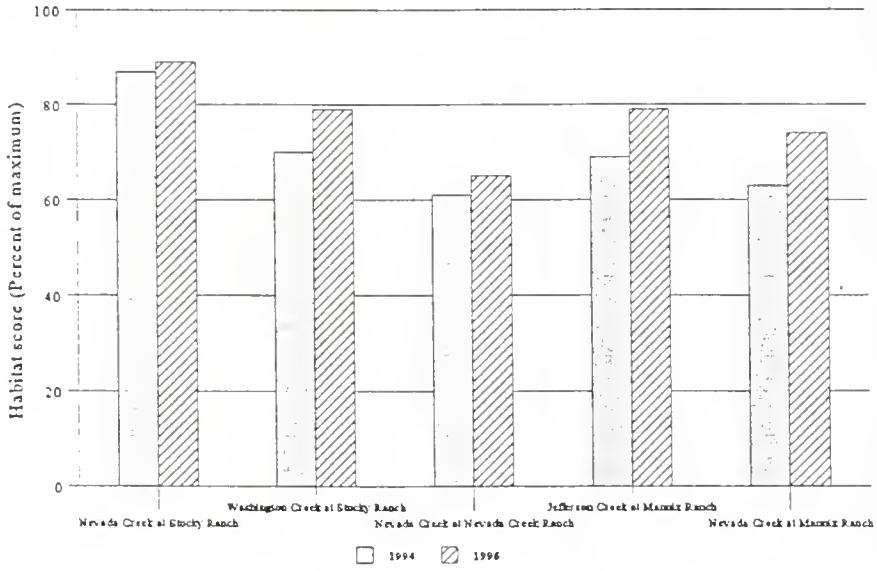
Habitat assessment methods were updated by DEQ since the 1994 study, so data from the survey of that year were recalculated for purposes of comparison to the 1996 survey. This recalculation resulted in changes in some of the condition categories assigned to sites for 1994.

Results and Discussion

Habitat assessment

Figure 1 compares the results of the habitat assessment of 1994 with that of 1996; the earlier assessment was standardized to account for the different methodologies employed in the two years of study. The habitat condition at one site, Washington Creek at the Stucky Ranch, improved from suboptimal in 1994 to optimal in 1996; at the other four sites, habitat condition categories remained the same between years. However, scores for some habitat parameters at some sites changed between years, resulting in improvement in total scores at all sites. For example, all sites showed perceived improvement in riparian width between years. Changes in the various parameters between years are summarized below.

Figure 1. Total habitat scores: 1994 and 1996. Nevada Creek drainage.



Just as in 1994, the reach of Nevada Creek at the Stucky Ranch received the best habitat score. Bank stability continued to score sub-optimally, but the riparian width score improved from sub-optimal to optimal in the 1996 assessment. Overall habitat condition at this site was rated optimal.

Improvement in the habitat assessment of Washington Creek at the Stucky Ranch between the study years is due to a perceived improvement in sediment deposition (rated sub-optimal in 1994, optimal in 1996) and in riparian width (rated marginal in 1994, optimal in 1996). Flow status was also given a higher score in 1996 than in 1994, "high" flows were noted at two other sites as well.

The reach of Nevada Creek at the Nevada Creek Ranch received the lowest total habitat assessment score of all five sites in both 1994 and 1996, and the reach was rated sub-optimal in both years. Even so, perceived improvements in embeddedness, bank stability and vegetative cover, as well as in riparian width resulted in a slight improvement in the total habitat score here.

Riparian width in the reach of Jefferson Creek at the F.Mannix Ranch was rated optimal in 1996 while it had been considered only marginal in 1994. The improvement in this parameter largely accounts for the increased total habitat score at this site. Overall habitat condition was rated sub-optimal in 1996.

Nevada Creek at the F.Mannix Ranch exhibited the greatest between-year improvement in total habitat score of all sites studied, though the site was rated sub-optimal in both years.

Embeddedness appeared to have improved from marginal in 1994 to optimal in 1996, with an accompanying improvement in sediment deposition from marginal in 1994 to sub-optimal in 1996. Both bank stability and bank vegetative cover were considered improved in 1996; these were rated marginal in the earlier year, and each improved to sub-optimal in 1996.

Macroinvertebrate communities

Macroinvertebrate taxa lists, metric results, and other information for each replicate are given in the Appendix.

The percent similarity between replicates ranged from 72% for those taken from Nevada Creek at the Nevada Creek Ranch to 87% for those taken from Nevada Creek at the Stucky Ranch. Mean percent similarity between replicates from all five sites was 77%. Percent similarity between sites was calculated based on combined replicates and is displayed in Figure 2.

Figure 2. Percent similarity between sites, based on combined replicates. Nevada Creek drainage: June 26, 1996.

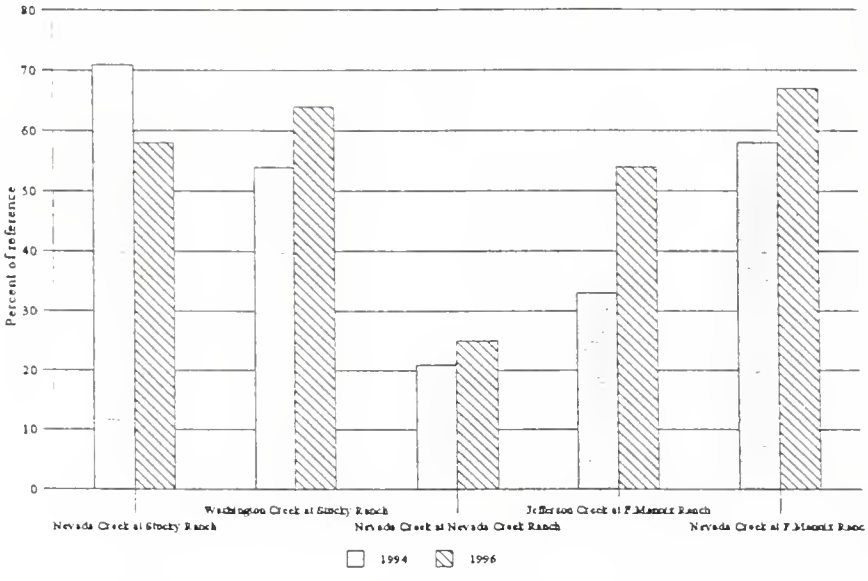
	Nevada at Stucky Ranch	Washington at Stucky Ranch	Nevada at Nevada Creek Ranch	Jefferson at Mannix Ranch
Washington at Stucky Ranch	61			
Nevada at Nevada Creek Ranch	2	15		
Jefferson at Mannix Ranch	28	45	21	
Nevada at Mannix Ranch	8	24	54	33

Macroinvertebrate communities at Nevada Creek at the Stucky Ranch and Washington Creek at the Stucky Ranch are very similar,but distinct from the communities at Nevada Creek at the Nevada Creek Ranch and Nevada Creek at the Mannix Ranch, which are similar to each other. The community at the Jefferson Creek site appears to be transitional between the two groups.

Figure 3 compares total bioassessment scores for each site with scores from 1994, recalculated using the updated reference values. Recalculation of 1994 scores resulted in

classification changes for three of five sites. In 1994, metrics calculated for communities of Nevada Creek at the Stucky Ranch and Washington Creek at the Stucky Ranch indicated non-impairment (McGuire 1995), but the performance of several metrics improved in the 1996 analysis, and these sites are re-classified as slightly impaired. Similarly, Jefferson Creek at the Mannix Ranch was considered moderately impaired based on the 1994 data, but is reclassified as slightly-to-moderately impaired. Impairment classifications for 1994 for Nevada Creek at the Nevada Creek Ranch and Nevada Creek at the Mannix Ranch remain unchanged. Table 3 summarizes the recalculation of metric scores and Table 1 shows the different internal reference values used in 1994 vs. 1996.

Figure 3. Total bioassessment scores: 1994 and 1996. Nevada Creek drainage.



Different internal reference values for five metrics account for the changes in impairment classifications for the 1994 bioassessments. Percent scrapers plus shredders, percent EPT, and EPT richness increased, while the biotic index and percent collectors (filterers plus gatherers) decreased. Reference values for the remaining three metrics did not improve in the 1996 bioassessment, and so remain the same as in the 1994 communities.

Nevada Creek at the Stucky Ranch, which received the highest bioassessment score of the five sites in the 1994 study, appears to have declined in biointegrity in 1996. The lower total bioassessment score and the resultant classification of slight impairment is attributable to the performance of four metrics (Table 3), and may be explained at least in part by unusually high flow conditions encountered by samplers in June 1996. Taxa richness declined from a mean of 31 in 1994 to 23 in 1996, but much of this decline is due to the drastic loss of chironomid taxa in the samples taken in 1996. Nine midge taxa comprised almost six percent of combined replicates in 1994, while in 1996 only three individual chironomids of three different taxa were collected. Decline in the taxa richness metric score is partially offset by the improvement in the biotic index score, also a reflection of the loss of chironomid taxa in 1996. The extremely low biotic index score of the community in the reach of Nevada Creek at the Stucky Ranch may be an unrealistic reference value for the remaining four sites in the drainage.

The benthic community of this reach received a lower score for the percent dominant taxon metric in 1996 compared to 1994. In both years, the dominant taxon was the mayfly *Cinygmula* sp., a highly sensitive heptageniid nymph. Dominance of this creature increased from a

mean of 26% in 1994 to 48% in 1996. In 1996, increased numbers of *Cinygmula* were accompanied by a decrease (from 23% in 1994 to 5% in 1996) in numbers of *Epeorus longimanus*, a more tolerant mayfly. This change could be due to flow conditions: *Cinygmula* is better adapted for refuge below stones than *Epeorus*, which typically clings to the sides of stones (Hynes 1970). High flow conditions may also have affected macroinvertebrate density. It was estimated at about 50 organisms per sampled foot in 1994, and about half that, or 26 organisms per foot in 1996.

A total of 38 taxa were collected from this reach in 1994, and 29 were collected in 1996. Combined replicates showed 60% similarity between years, with 20 taxa in common. Even though the total bioassessment score has declined in the interval, the benthic community of Nevada Creek at the Stucky Ranch still exhibits a high degree of biointegrity, exemplified by biotic index and community tolerance quotient scores indicating an assemblage extremely sensitive to pollution, sedimentation and elevated temperature. Coupled with a habitat condition judged optimal, the total bioassessment score indicates impacts which are likely due to unusually high and late seasonal flows.

Washington Creek at the Stucky Ranch was classified as slightly impaired, but both habitat scores and bioassessment scores improved in 1996 compared to 1994. Just as for Nevada Creek at the Stucky Ranch, at least some of the impairment indicated by bioassessment may be due to high flow conditions. Taxa richness declined from a mean of 31 in 1994 to 28 in 1996, but five midge taxa were collected in 1994, while a single individual chironomid occurred in the 1996 samples. A decline in the biotic index corresponds to the loss of midges. *Cinygmula* dominated the benthic communities in both years, but its relative abundance increased from only 23% in the earlier year to 56% in 1996, reducing the percent dominant taxon metric score from its maximum value to its minimum. This was more than offset in the total bioassessment score by improvement in three other metrics. The percentage of collecting feeders declined, with the decrease mostly occurring among the gatherers; the abundance of filtering feeders remained about the same between years. At the same time, there was an almost equal increase in the abundance of scrapers and shredders, the increase being mostly among the scraper feeders. This realignment of functional feeding groups suggests a diminishment of fine organic sediment deposits. A decline in the number of tubificid worms (from 7% of combined replicates in 1994 to 1% in 1996) seems to support this suggestion. Biotic index and community tolerance quotient scores indicate a benthic community quite sensitive to impact from pollution.

The total number of taxa collected from this reach was 43 in 1994, and 35 in 1996; the decline is accounted for by the loss of midge taxa and the decreased diversity of elmid beetles. Combined replicates showed 55% similarity between years, and had 23 taxa in common. With habitat perceived as optimal, and no indication within the macroinvertebrate community that water quality was impacted (the biotic index was 1.40), slight impairment of biointegrity may be due to unseasonably high flows.

Nevada Creek at the Nevada Creek Ranch is the most downstream reach studied, and just as in 1994, it received the lowest habitat and bioassessment scores among the five sites studied. However, both scores showed a small improvement in 1996. Several features of the benthic community suggest that impacts in this reach have shifted from organic particulates suspended in the water column to deposits of organic material as sediments. Filtering feeders declined from a

mean of 38% for samples collected in 1994 to 12% in 1996, with fewer hydropsychid caddisflies and no black flies in the samples from 1996. At the same time, a large increase in the abundance of tubificid worms (<1% in 1994, 14% in 1996) was noted. Scraper feeders showed a great increase in abundance, from 1% of the community in 1994 to 43% in 1996, suggesting a possible decrease in turbidity with an increase in algal films on stony substrates.

Habitat scores indicate sub-optimal condition in this reach, but bioassessment scores indicate a moderate, almost severe degree of impairment. The discrepancy between these two scores suggests that water quality impacts as well as habitat degradation is affecting the biointegrity of the benthic community of Nevada Creek at the Nevada Creek Ranch (see Figure 4). The metals tolerance index is quite high (mean 4.14) as are the biotic index (mean 4.94) and the community tolerance quotient (mean 76). Impact from metals or other toxic pollutants may contribute to impairment of biointegrity.

While the relative abundance of the dominant taxon remained similar in both years, the organism which dominated the community in 1994 was the gatherer *Baetis tricaudatus* while in 1996 *Ephemerella inermis*, a scraper, was the most abundant organism. The total number of taxa collected from this reach was 26 in 1994 and 23 in 1996. Percent similarity of combined replicates between years was 41%, with 13 taxa in common. Low taxa richness and a community dominated by pollution-tolerant taxa were consistent with habitat degradation and water quality problems.

Of all five sites, Jefferson Creek at the Mannix Ranch showed the greatest improvement in bioassessment scores between the two study years; no metric score declined from 1994 to 1996. Total habitat score improved at this site as well, with an increase in the perceived width of the riparian zone the major factor in this improvement. Sub-optimal habitat condition, due mainly to perceived bank instability and erosion and associated impact to the substrate, was consistent with slight-to-moderate impairment of biotic integrity. However, the benthic community appeared to be less affected by habitat degradation in 1996 than in the earlier year. In addition, improved water quality (see Figure 4) is suggested by the dramatic decrease in biotic index, the decrease in filter-feeding organisms, and the increase in the abundance of scraping organisms. The decrease in the biotic index should have affected the total bioassessment score, but did not, due to what may be an unrealistically low reference value. The filtering black fly *Simulium* sp. dominated samples from 1994, comprising 35% of combined replicates, while in 1996, the less-tolerant scraper *Epeorus albertae* dominated, making up 27% of the organisms collected. The relative abundance of *Simulium* was only 4% in 1996.

An increase in the diversity of the macroinvertebrate community in 1996 (33 taxa were collected in 1994, 37 in 1996) was due to an increase in the number of stonefly taxa , *Isoperla* sp., *Kogotus* sp. and a chloroperlid appearing, and also by the addition of several sensitive mayflies including *Drunella flavilinea*, *D. spinifera*, and *Ameletus* sp. As a result, the EPT richness metric and the percent EPT metric both improved between years.

High flows may be implicated in some of the changes in the benthic community that were apparent in 1996. Midge taxa numbers and abundance declined (8 taxa in 1994 comprising 12% of samples, 3 taxa in 1996 comprising 5% of samples) and macroinvertebrate densities also appeared lower: an average of 144 organisms per sampled foot was calculated from the 1994 data, while a density of only 28 organisms per sampled foot was calculated from the 1996 data. The presence of *Heterlimnius* sp., a greater abundance of heptageniid mayflies, the appearance of

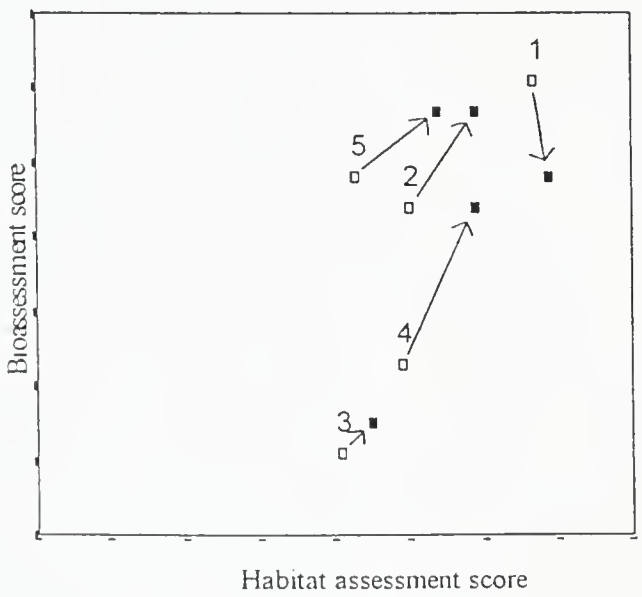
Drunella sp., and fewer baetid mayflies suggests that water temperatures in 1996 were colder than in 1994.

Percent similarity of combined replicates between years was 34%, the lowest of the five sites. Samples from the two years shared 23 taxa. Changes in the proportional representation of taxa accounts for most of the dissimilarity between years.

In the reach of Nevada Creek at the Mannix Ranch the benthic community indicated slight impairment of biointegrity. Impacts in the form of suspended organic particles seem to have diminished somewhat in 1996 compared to 1994 since the relative abundance of filtering organisms (28% in 1994, and 12% in 1996) fell off in the later year. The filtering caddisfly *Brachycentrus occidentalis* dominated the community sampled in 1994 (16% in the earlier year, 3% in 1996) but the dominant taxon in 1996 was the scraper *Ephemerella inermis*. The increase in the abundance of scraping organisms (12% in 1994, 54% in 1996) supports the suggestion that turbidity in this reach decreased between the two study years. The improvement in the metric score for percent shredders plus scrapers wholly accounts for the improvement in total bioassessment score in 1996 for this site.

Flows which were higher than usual and later than usual may have influenced the macroinvertebrate assemblage in 1996 in this reach. Shredding organisms, which comprised 6% of the organisms sampled in 1994, are absent from the 1996 samples, suggesting that large organic materials may have been swept out of the reach. Apparently, a large amount of this large organic material was the algae *Nostoc*, since 31 individual organisms (5%) collected in 1994 were the midge *Cricotopus nostococladius*. Twelve midge taxa made up 26% of macroinvertebrates in 1994, but chironomid abundance was reduced to 11% in 1996, with only seven taxa represented. Density of macroinvertebrates was estimated to average 43 organisms per sampled foot in the earlier year, and 13 organisms per sampled foot in 1996.

Figure 4. Bioassessment vs. habitat assessment. Nevada Creek drainage.



A total of 47 taxa were collected in 1994, and 39 in 1996. The decrease in taxa richness is explained by the loss of chironomid taxa as well as by the disappearance of stoneflies in samples between the two years. Percent similarity between years was 46%; the combined samples had 28 taxa in common.

Figure 4 shows the relationship between the total habitat scores and total bioassessment scores of the five sites. Each site is represented by two points on the graph, one point (an open box) for the data of 1994 and the other (a filled box) for that of 1996. Arrows between points

indicate the direction of change of scores for that site between years. Sites are indicated by numbers as follows:

1 = Nevada Creek at the Stucky Ranch
2 = Washington Creek at the Stucky Ranch
3 = Nevada Creek at the Nevada Creek Ranch
4 = Jefferson Creek at the F.Mannix Ranch
5 = Nevada Creek at the F.Mannix Ranch.

The cluster of points in the upper right of the graph illustrates the expected relationship between habitat and biotic scores in situations where habitat conditions are generally good and water quality non-impaired. Bioassessment scores are high; communities have balanced representations of the various functional feeding groups, are diverse, with high proportional abundances of mayflies, stoneflies and caddisflies, and exhibit high sensitivity to pollution. Points representing sites 2, 5 and 1 fall within this cluster in both years.

Site 3 illustrates the relation between habitat and biotic scores in situations where water quality impairment is impacting biointegrity. Habitat condition scores are not extremely poor, yet bioassessment scores are lower than expected. The community here is pollution-tolerant and less diverse. Site 4 illustrates a similar condition in 1994, but a dramatic improvement is apparent by 1996.

Conclusions

- Bioassessments in 1996 may have been influenced by unusually high flows, which decreased taxa richness by eliminating chironomids, and subsequently increased biotic index assessment scores. Evidence of this effect occurred at four of the five sites studied.

- A decrease in suspended fine organic particles in 1996 is suggested by the composition of benthic communities of Nevada Creek at both the Nevada Creek Ranch and the F.Mannix Ranch.

- Organic sediment deposits appear to have increased in 1996 at the Nevada Creek Ranch site. A decrease in deposits is indicated in Washington Creek at the Stucky Ranch.

- Water quality degradation is evident in Nevada Creek at the Nevada Creek Ranch, with little improvement between years. Water quality appears to have improved significantly between years in Jefferson Creek at the F.Mannix Ranch.

- Habitat assessments indicated improved conditions at all five sites between the years of the study Increased width of the riparian zone was perceived to have significantly increased at four of the five sites.

TABLES

Table 1. **Internal reference values and criteria for assigning scores to metrics based on percent comparability to reference values (adapted from McGuire 1995): NEVADA CREEK DRAINAGE, 1996.**

	Nevada Creek reference		Scoring Criteria				
metric	1996[1]	(1994)	6	4	2	0	*
Taxa richness	39	(39)	> 80%	80-60%	60-40%	< 40%	a
EPT richness	22	(20)	> 85%	85-70%	70-50%	< 50%	a
Biotic index	0.60	(1.2)	> 90%	90-80%	80-70%	< 70%	b
% dominant taxon	16	(16)	> 60%	60-45%	45-30%	< 30%	b
% Collector + FF	13	(19)	> 90%	90-80%	80-70%	< 70%	b
% Scraper +Shredder	81	(71)	> 80%	80-60%	60-40%	< 40%	a
% EPT	96	(88)	> 75%	75-50%	50-25%	< 25%	a
% Hydropsych. of Trichop.	0	(0)	< 50%	50-70%	70-90%	> 90%	c

[1] 1996 Internal reference values are the "best" values among those calculated in two years of Nevada Creek data.

* a = score is ratio of study site to reference x 100.

* b = score is ratio of reference to study site x 100.

* c = score is based on the actual value, not a percentage of reference.

Table 2. Criteria for the assessment of biologically significant environmental degradation (adapted from Plafkin et al. 1989).

% Comparability to reference	Classification
>83	Non-impaired
54-79	Slightly impaired
21-50	Moderately impaired
<17	Severely impaired

Table 3. Mean Metric values, percentage of reference, and bioassessments for streams of the Nevada Creek drainage.

metric	Nevada Creek at Stucky Ranch	Washington Creek at Stucky Ranch	Nevada Creek at Nevada Creek Ranch	Jefferson Creek at F.Mannix Ranch	Nevada Creek at F.Mannix Ranch
	1996 (1994)	1996 (1994)	1996 (1994)	1996 (1994)	1996 (1994)
Taxa richness	23 (31)	28 (31)	18 (20)	30 (26)	32 (39)
EPT richness	18 (19)	18 (17)	8 (10)	18 (11)	20 (20)
Biotic index	0.74 (1.2)	1.4 (2.7)	4.94 (4.5)	2.72 (4.7)	3.9 (3.9)
% dominant taxon	48 (26)	56 (23)	34 (47)	27 (35)	26 (16)
% Collector-FF	30 (19)	14 (44)	44 (95)	32 (85)	45 (77)
% Scrapers + Shredders	62 (71)	80 (43)	43 (2)	65 (11)	54 (18)
% EPT	95 (88)	82 (68)	71 (85)	74 (30)	72 (60)
% Hydropsychinae of Trichoptera	0 (0)	5 (2)	96 (97)	67 (78)	41 (35)
% of reference					
Taxa richness	59 (79)	72 (79)	46 (51)	77 (67)	82(100)
EPT richness	82 (86)	82 (77)	36 (45)	82 (50)	91 (91)
Biotic index	81 (50)	43 (22)	12 (13)	22 (13)	15 (15)
% dominant taxon	33 (62)	28 (70)	47 (34)	59 (46)	62(100)
% Collector-FF	43 (68)	93 (30)	30 (14)	41 (15)	29 (17)
% Scrapers + Shredders	77 (88)	99 (53)	53 (2)	80 (14)	67 (22)
% EPT	99 (92)	85 (71)	74 (88)	77 (31)	75 (63)
% Hydropsychinae of Trichoptera	na	na	na	na	na
metric score					
Taxa richness	2 (4)	4 (4)	2 (2)	4 (4)	6 (6)
EPT richness	4 (6)	4 (4)	0 (0)	4 (2)	6 (6)
Biotic index	4 (0)	0 (0)	0 (0)	0 (0)	0 (0)
% dominant taxon	2 (6)	0 (6)	4 (2)	4 (4)	6 (6)
% Collector-FF	0 (0)	6 (0)	0 (0)	0 (0)	0 (0)
% Scrapers + Shredders	4 (6)	6 (2)	2 (0)	4 (0)	4 (0)
% EPT	6 (6)	6 (4)	4 (6)	6 (2)	4 (4)
% Hydropsychinae of Trichoptera	6 (6)	6 (6)	0 (0)	4 (4)	6 (6)
total score	28 (34)	32 (26)	12 (10)	26 (16)	32 (28)
% reference	58 (71)	67 (54)	25 (21)	54 (33)	67 (58)
classification	SLI(SLI)	SLI (SLI)	MOD (MOD)	SLI-MOD (S-M)	SLI (SLI)

* classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired.

Table 4. Stream and riparian habitat assessment: Nevada Creek drainage, June 26, 1996.

Max. possible score	Location:	1. Nevada Creek at Stucky Ranch	2. Washington Creek at Stucky Ranch	3. Nevada Creek at Nevada Creek Ranch	4. Jefferson Creek at F.Mannix Ranch	5. Nevada Creek at F.Mannix Ranch	Mean scores in both study years	
							1994	1996
	Parameter							
10	riffle development	9	9	5	8	7	9	8
10	substrate development	9	7	6*	7	9	7	8
20	embeddedness	18	15	12	15	16	13	15
20	channel alteration	20	15	13	15	17	13	16
20	sediment deposition	18	16	10	15	11	10	14
20	flow status	20	17	11	20	14	13	16
10/10	bank stability (right/left)	7 / 7	7 / 7	8 / 7	6 / 6	7 / 6	12	14
10/10	bank vegetative cover (right/left)	9 / 9	8 / 8	8 / 8	8 / 8	7 / 6	14	16
10/10	riparian width (right/left)	8 / 9	9 / 9	8 / 8	9 / 9	9 / 9	10	17
160	TOTAL:	143	127	104	126	118	101	124
PERCENT OF MAXIMUM:		89	79	65	79	74	63	78
CONDITION[1]:		OPTIMAL	OPTIMAL	SUB-OPTIMAL	SUB-OPTIMAL	SUB-OPTIMAL		

1. Condition categories: Optimal > 81% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%.

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APPENDIX

Nevada Creek Drainage
Aquatic Macroinvertebrate Data

June 26, 1996

Macroinvertebrate Taxonomic Data

NEVADA CREEK at Stucky Ranch	1.1		1.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
MISC. TAXA						
Oligochaeta: Lumbriculidae	0	0	2	0.60	4	CG
TOTAL: MISC. TAXA	0	0	2	0.60		
EPHEMEROPTERA						
Baetis bicaudatus	28	8.28	11	3.32	2	CG
Baetis tricaudatus	3	0.89	2	0.60	4	CG
Drunella coloradensis	62	18.34	66	19.94	0	CG
Drunella doddsi	24	7.10	22	6.65	1	SC
Drunella spinifera	0	0	2	0.60	0	PR
Cinygmula spp.	170	50.30	154	46.53	0	SC
Epeorus longimanus	17	5.03	17	5.14	1	SC
Rhithrogena hageni	0	0	1	0.30	0	SC
Rhithrogena robusta	1	0.30	0	0	0	SC
TOTAL: EPHEMEROPTERA	305	90.24	275	83.08		
PLECOPTERA						
Chloroperlidae	3	0.89	1	0.30	1	PR
Doroneuria sp.	4	1.18	4	1.21	0	PR
Kogotus sp.	2	0.59	6	1.81	1	PR
Pteteticlla expansa	0	0	1	0.30	2	PR
TOTAL: PLECOPTERA	9	2.66	12	3.63		
TRICHOPTERA						
Arctopsyche grandis	1	0.30	0	0	2	CF
Rhyacophila spp. (pupae)	0	0	2	0.60	1	PR
Rhyacophila Alberta Gr.	1	0.30	0	0	0	PR
Rhyacophila Betteni Gr.	2	0.59	9	2.72	0	PR
Rhyacophila Brunnea Gr.	2	0.59	4	1.21	2	PR
Rhyacophila narvae	1	0.30	2	0.60	0	PR
Rhyacophila Sibirica Gr.	1	0.30	0	0	0	PR
Rhyacophila verrula	0	0	1	0.30	0	PR
Neophylax sp.	2	0.59	7	2.11	3	SC
TOTAL: TRICHOPTERA	10	2.96	25	7.55		
COLEOPTERA						
Heterlimnius sp.	9	2.66	6	1.81	3	CG
TOTAL: COLEOPTERA	9	2.66	6	1.81		
DIPTERA						
Ceratopogonidae	1	0.30	0	0	6	PR
Simuliidae (pupa)	1	0.30	7	2.11	6	CF
Prosimulium sp.	0	0	1	0.30	4	CF
Hexatoma sp	3	0.89	0	0	2	PR
TOTAL: DIPTERA	5	1.48	8	2.42		

Continued...

NEVADA CREEK at Stucky Ranch	1.1		1.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
CHIRONOMIDAE						
Cardiocladius sp.	0	0	1	0.30	5	PR
Diamesa sp.	0	0	1	0.30	5	CG
Eukiefferiella Brehmi Gr.	0	0	1	0.30	8	CG
TOTAL: CHIRONOMIDAE	0	0	3	0.91		
GRAND TOTAL	338	100.00	331	100.00		

1 Functional feeding group designations are given in TABLE A.
2 Biotic index scores for individual taxa, as given in Bukantis, 1996

Aquatic Macroinvertebrate Data: Nevada Creek at Stucky Ranch: June 26, 1996

Sample:	1.1	1.2
% of sample used:	60	40
Subsample size	338	331
Taxa richness	21	25
EPT richness	17	18
Biotic index	0.87	0.60
% Dominant taxon	50	47
% EPT	96	94
% Collectors (g+f)	31	29
% Scrapers + Shredders	63	61
% Hydropsychinae of Trich	0	0
Metals tolerance index	0.59	0.48
Shannon Diversity	2.48	2.78
EPT/Chironomidae	undefined	104
CTQa	37	48
%Baetidae of Ephemeroptera	10	5
% Coleoptera	3	2
% Diptera	1	2
% Chironomidae	0	1
% Ephemeroptera	90	83
% Plecoptera	3	4
% Trichoptera	3	8
% multivoltine	7	4
% univoltine	88	90
% semivoltine	5	6

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	0.6	2	2	2
Collector-Gatherers	30	4	27	7
Shredders	0	0	0	0
Scrapers	63	5	61	5
Predators	6	10	10	11

Est. total number of organisms	563	828
Est. number collected per foot	19	33
Est. number collected per minute	563	828

Macroinvertebrate Taxonomic Data

WASHINGTON CREEK at Stucky Ranch	2.1		2.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
MISC. TAXA						
Turbellaria: Polycelis coronata	0	0	3	0.87	4	PR
Oligochaeta: Tubificidae	2	0.59	5	1.46	10	CG
Oligochaeta: Lumbriculidae	0	0	3	0.87	4	CG
Sphaeriidae	6	1.77	7	2.04	8	CF
TOTAL: MISC. TAXA	8	2.36				
Baetis tricaudatus	5	1.47	6	1.75	4	CG
Diphetor hageni	0	0	2	0.58	5	CG
Drunella flavilinea	5	1.47	11	3.21	2	CG
Drunella spinifera	1	0.29	2	0.58	0	PR
Ephemerella inermis	6	1.77	6	1.75	4	SC
Serratella tibialis	2	0.59	3	0.87	2	CG
Cinygmula spp.	214	63.13	164	47.81	0	SC
Epeorus albertae	1	0.29	3	0.87	2	SC
Epeorus longimanus	30	8.85	25	7.29	1	SC
Rhithrogena hageni	1	0.29	0	0	0	SC
Paraleptophlebia heteronea	3	0.88	1	0.29	1	CG
TOTAL: EPHEMEROPTERA	268	79.06	223	65.01		
PLECOPTERA						
Chloroperlidae	5	1.47	4	1.17	1	PR
Hesperoperla pacifica	0	0	1	0.29	1	PR
Kogotus sp.	0	0	2	0.58	1	PR
TOTAL: PLECOPTERA	5	1.47	7	2.04		
TRICHOPTERA						
Arctopsyche grandis	1	0.29	0	0	2	CF
Amiocentrus aspilus	1	0.29	0	0	3	CG
Brachycentrus americanus	1	0.29	14	4.08	1	SC
Hydropsychidae (pupa)	1	0.29	0	0	4	CF
Hydropsyche sp.	0	0	2	0.58	5	CF
Lepidostoma sp.	1	0.29	2	0.58	1	SH
Onocosmoecus sp.	0	0	1	0.29	3	OM
Rhyacophila Brunnea Gr.	11	3.24	7	2.04	2	PR
Neophylax sp.	4	1.18	15	4.37	3	SC
TOTAL: TRICHOPTERA	20	5.90	41	11.95		
COLEOPTERA						
Heterlimnius sp.	19	5.60	2	0.58	3	CG
Optioservus sp.	15	4.42	44	12.83	5	SC
Zaitzevia sp.	1	0.29	3	0.87	4	CG
TOTAL: COLEOPTERA	35	10.32	49	14.29		
DIPTERA						
Dolichopodidae	0	0	1	0.29	4	PR

Continued...

Macroinvertebrate Taxonomic Data

WASHINGTON CREEK at Stucky Ranch	2.1		2.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
Simulidae (pupa)	1	0.29	0	0	6	CF
Dicranota sp.	0	0	2	0.58	3	PR
Hexatoma sp.	2	0.59	1	0.29	2	PR
TOTAL: DIPTERA	3	0.88	4	1.17		
CHIRONOMIDAE						
Tanytarsus sp.	0	0	1	0.29	6	CF
TOTAL: CHIRONOMIDAE	0	0	1	0.29		
GRAND TOTAL	339	100.00	343	100.00		

Aquatic Macroinvertebrate Data: Washington Creek at Stucky Ranch: June 26, 1996

Sample:	2.1	2.2
% of sample used:	20	20
Subsample size	339	343
Taxa richness	25	30
EPT richness	18	19
Biotic index	1.05	1.75
% Dominant taxon	63	48
% EPT	86	79
% Collectors (g+f)	14	13
% Scrapers + Shredders	81	80
% Hydropsychinae of Trich	5	5
Metals tolerance index	0.77	1.43
Shannon Diversity	2.31	3.05
EPT/Chironomidae	undefined	271
CTQa	49	55
%Baetidae of Ephemeroptera	2	4
% Coleoptera	10	14
% Diptera	1	1
% Chironomidae	0	<1
% Ephemeroptera	79	65
% Plecoptera	2	2
% Trichoptera	6	12
% multivoltine	1	3
% univoltine	85	75
% semivoltine	14	22

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	3	4	3	3
Collector-Gatherers	11	8	10	9
Shredders	<1	1	<1	1
Scrapers	80	8	79	7
Predators	6	4	7	9

Est. total number of organisms	1695	1715
Est. number collected per foot	113	64
Est. number collected per minute	2260	1715

Macroinvertebrate Taxonomic Data

NEVADA CREEK at Nevada Creek Ranch	3.1		3.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
MISC. TAXA						
Nematoda	0	0	4	1.16	5	OM
Oligochaeta: Tubificidae	7	2.04	90	26.09	10	CG
Oligochaeta: Lumbriculidae	2	0.58	3	0.87	4	CG
Sphaeriidae	1	0.29	0	0	8	CF
TOTAL: MISC. TAXA	10	2.92	97	28.12		
EPHEMEROPTERA						
Acentrella sp.	17	4.96	34	9.86	4	CG
Baetis tricaudatus	58	16.91	14	4.06	4	CG
Diphetor hageni	4	1.17	0	0	5	CG
Ephemerella inermis	117	34.11	117	33.91	4	SC
Serratella tibialis	2	0.58	0	0	2	CG
Epeorus longimanus	2	0.58	1	0.29	1	SC
Nixe sp.	0	0	2	0.58	4	SC
TOTAL: EPHEMEROPTERA	200	58.31	168	48.7		
PLECOPTERA						
Isoperla sp.	31	9.04	3	0.87	2	PR
TOTAL: PLECOPTERA	31	9.04	3	0.87		
TRICHOPTERA						
Helicopsyche borealis	0	0	2	0.58	3	SC
Hydropsyche spp.	52	15.16	33	9.57	5	CF
Onocosmoecus sp.	0	0	1	0.29	3	OM
TOTAL: TRICHOPTERA	52	15.16	36	10.43		
COLEOPTERA						
Optioservus sp.	33	9.62	23	6.67	5	SC
TOTAL: COLEOPTERA	33	9.62	23	6.67		
DIPTERA						
Hexatoma sp.	0	0	1	0.29	2	PR
Tipula sp.	1	0.29	1	0.29	4	SH
TOTAL: DIPTERA	1	0.29	2	0.58		
CHIRONOMIDAE						
Eukiefferiella Devonica Gr.	1	0.29	1	0.29	8	CG
Microtendipes sp.	9	2.62	9	2.61	6	CG
Orthocladius spp.	1	0.29	3	0.87	6	CG
Polypedilum sp.	4	1.17	3	0.87	6	CG
Thienemanniella sp.	1	0.29	0	0	6	CG
TOTAL: CHIRONOMIDAE	16	4.66	16	4.64		
GRAND TOTAL	343	100.00	345	100.00		

Aquatic Macroinvertebrate Data: Nevada Creek at Nevada Creek Ranch: June 26, 1996

Sample:	3.1	3.2
% of sample used:	20	80
Subsample size	343	345
Taxa richness	18	19
EPT richness	8	9
Biotic index	4.10	5.78
% Dominant taxon	34	34
% EPT	82	60
% Collectors (g+f)	32	55
% Scrapers + Shredders	45	42
% Hydropsychinae of Trich	1	92
Metals tolerance index	3.96	4.33
Shannon Diversity	2.88	2.80
EPT/Chironomidae	18	13
CTQa	80	72
%Baetidae of Ephemeroptera	40	29
% Coleoptera	10	7
% Diptera	<1	<1
% Chironomidae	5	5
% Ephemeroptera	58	49
% Plecoptera	9	<1
% Trichoptera	15	10
% multivoltine	25	17
% univoltine	64	62
% semivoltine	11	20

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	15	2	10	1
Collector-Gatherers	31	11	46	8
Shredders	<1	1	<1	1
Scrapers	44	3	42	5
Predators	9	1	1	2

Est total number of organisms	1715	431
Est. number collected per foot	52	13
Est number collected per minute	1715	431

Macroinvertebrate Taxonomic Data

JEFFERSON CREEK at Francis Mannix Ranch	4.1		4.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
MISC. TAXA						
Nematoda	0	0	1	0.31	5	OM
Oligochaeta: Tubificidae	0	0	1	0.31	10	CG
Oligochaeta: Lumbriculidae	4	1.17	0	0	10	CG
Sphaeriidae	7	2.05	7	2.18	8	CF
TOTAL: MISC. TAXA	11	3.22	9	2.80		
ODONATA						
Ophiogomphus sp.	5	1.46	5	1.56	5	PR
TOTAL: ODONATA	5	1.46	5	1.56		
EPHEMEROPTERA						
Baetis tricaudatus	16	4.68	19	5.92	4	CG
Diphetor hagem	8	2.34	1	0.31	5	CG
Drunella flavilinea	30	8.77	28	8.72	2	CG
Drunella spinifera	1	0.29	1	0.31	0	PR
Ephemerella inermis	3	0.88	1	0.31	4	SC
Serratella tibialis	0	0	2	0.62	2	CG
Cinygmula spp.	77	22.51	50	15.58	0	SC
Epeorus albertae	82	23.98	97	30.22	2	SC
Epeorus longimanus	7	2.05	9	2.80	1	SC
Nixe sp.	7	2.05	4	1.25	4	SC
Paraleptophlebia heteronea	2	0.58	4	1.25	1	CG
Ameletus sp.	2	0.58	0	0	0	CG
TOTAL: EPHEMEROPTERA	235	68.71	216	67.29		
PLECOPTERA						
Chloroperlidae	0	0	1	0.31	1	PR
Hesperoperla pacifica	1	0.29	0	0	1	PR
Isoperla sp.	1	0.29	0	0	2	PR
Kogotus sp.	1	0.29	0	0	1	PR
TOTAL: PLECOPTERA	3	0.88	1	0.31		
TRICHOPTERA						
Amiocentrus aspilus	0	0	1	0.31	3	CG
Agapetus sp.	4	1.17	0	0	0	SC
Hydropsyche spp.	15	4.39	9	2.80	5	CF
Hydroptila sp.	1	0.29	0	0	6	CG
Rhyacophila Brunnea Gr.	1	0.29	2	0.62	2	PR
Neophylax sp.	2	0.58	1	0.31	3	SC
TOTAL: TRICHOPTERA	23	6.73	13	4.05		
COLEOPTERA						
Heterlimnius sp.	22	6.43	0	0	3	CG
Lara avara	1	0.29	0	0	1	SH
Optioservus sp.	21	6.14	38	11.84	5	SC
Zaitzevia sp.	1	0.29	1	0.31	4	CG

Continued...

Macroinvertebrate Taxonomic Data

JEFFERSON CREEK at Francis Mannix Ranch	4.1		4.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
TOTAL: COLEOPTERA	45	13.16	39	12.15		
DIPTERA						
Simuliidae (pupae)	0	0	7	2.18	6	CF
Prosimulium sp.	1	0.29	7	2.18	4	CF
Simulium sp.	0	0	8	2.49	5	CF
Antocha sp.	2	0.58	1	0.31	3	CG
TOTAL: DIPTERA	3	0.88	23	7.17		
CHIRONOMIDAE						
Cricotopus nostococladius	11	3.22	14	4.36	6	SH
Eukiefferiella Brehmi Gr.	2	0.58	0	0	8	CG
Orthocladius spp.	4	1.17	1	0.31	6	CG
TOTAL: CHIRONOMIDAE	17	4.97	15	4.67		
GRAND TOTAL	342	100.00	321	100.00		

Aquatic Macroinvertebrate Data: Jefferson Creek at Francis Mannix Ranch: June 26, 1996

Sample:	4.1	4.2
% of sample used:	70	50
Subsample size	342	321
Taxa richness	31	28
EPT richness	19	16
Biotic index	2.58	2.86
% Dominant taxon	24	30
% EPT	76	72
% Collectors (g+f)	34	30
% Scrapers + Shredders	63	67
% Hydropsychinae of Trich	65	69
Metals tolerance index	1.55	1.56
Shannon Diversity	2.52	3.46
EPT/Chironomidae	15	15
CTQa	63	64
%Baetidae of Ephemeroptera	10	9
% Coleoptera	13	12
% Diptera	<1	7
% Chironomidae	5	5
% Ephemeroptera	69	67
% Plecoptera	<1	<1
% Trichoptera	7	4
% multivoltine	10	9
% univoltine	73	76
% semivoltine	17	15

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	7	3	12	5
Collector-Gatherers	27	12	18	10
Shredders	4	2	4	1
Scrapers	59	8	62	7
Predators	3	6	3	4

Est. total number of organisms	489	642
Est. number collected per foot	20	36
Est. number collected per minute	489	642

Macroinvertebrate Taxonomic Data

NEVADA CREEK at Francis Mannix Ranch	5.1		5.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
MISC. TAXA						
Oligochaeta: Lumbriculidae	1	0.28	0	0	4	CG
Oligochaeta: Naididae	2	0.56	2	0.60	8	CG
Planorbidae	0	0	1	0.30	6	SC
TOTAL: MISC. TAXA	3	0.85	3	0.90		
EPHEMEROPTERA						
Acentrella sp.	27	7.63	24	7.16	4	CG
Baetis tricaudatus	1	0.28	2	0.60	4	CG
Diphetor hageni	1	0.28	3	0.90	5	CG
Drunella flavilinea	12	3.39	14	4.18	2	CG
Drunella grandis	0	0	3	0.90	2	CG
Ephemerella inermis	102	28.81	74	22.09	4	SC
Serratella tibialis	3	0.85	2	0.60	2	CG
Timpanoga hecuba	5	1.41	0	0	2	CG
Cinygmula spp.	24	6.78	16	4.78	0	SC
Epeorus albertae	9	2.54	18	5.37	2	SC
Epeorus longimanus	3	0.85	2	0.60	1	SC
Nixe sp.	0	0	1	0.30	4	SC
Paraleptophlebia heteronea	3	0.85	6	1.79	1	CG
Ameletus sp.	0	0	1	0.30	0	CG
TOTAL: EPHEMEROPTERA	190	53.67	166	49.55		
PLECOPTERA						
Isoperla sp.	1	0.28	0	0	2	PR
TOTAL PLECOPTERA	1	0.28	0	0		
TRICHOPTERA						
Amiocentrus aspilus	11	3.11	11	3.28	3	CG
Brachycentrus americanus	0	0	1	0.30	1	SC
Brachycentrus occidentalis	8	2.26	13	3.88	2	CF
Agapetus sp.	5	1.41	2	0.60	0	SC
Helicopsyche borealis	4	1.13	7	2.09	3	SC
Hydropsyche spp.	37	10.45	21	6.27	5	CF
Hydroptila sp.	8	2.26	8	2.39	6	CG
Oecetis sp.	0	0	1	0.30	8	PR
Dicosmoecus sp.	1	0.28	1	0.30	2	SC
TOTAL: TRICHOPTERA	74	20.9	65	19.40		
COLEOPTERA						
Heterlimnius sp.	1	0.28	1	0.30	3	CG
Optioservus sp.	63	17.80	39	11.64	5	SC
Zaitzevia sp.	1	0.28	2	0.60	4	CG
TOTAL: COLEOPTERA	65	18.36	42	12.54		
DIPTERA						
Simulium sp.	0	0	1	0.30	5	CF

Continued...

Macroinvertebrate Taxonomic Data

NEVADA CREEK at Francis Mannix Ranch	5.1		5.2			
Taxon	#	%	#	%	BI[2]	FFG[1]
Antocha sp.	0	0	1	0.30	3	CG
Hexatoma sp	1	0.28	4	1.19	2	PR
TOTAL: DIPTERA	1	0.28	6	1.79		
CHIRONOMIDAE						
Cricotopus sp.	0	0	4	1.19	7	CG
Diamesa sp.	1	0.28	0	0	5	CG
Eukiefferiella Devonica Gr.	0	0	16	4.78	8	CG
Microtendipes sp.	0	0	1	0.30	6	CG
Orthocladius sp.	3	0.85	23	6.87	6	CG
Parametriocnemus sp.	0	0	1	0.30	5	CG
Polypedilum sp.	16	4.52	7	2.09	6	CG
TOTAL: CHIRONOMIDAE	20	5.65	53	15.82		
GRAND TOTAL	354	100.00	335	100.00		

Aquatic Macroinvertebrate Data: Nevada Creek at Francis Mannix Ranch: June 26, 1996

Sample:	5.1	5.2
% of sample used:	95	80
Subsample size	354	335
Taxa richness	28	37
EPT richness	19	22
Biotic index	3.81	3.99
% Dominant taxon	29	22
% EPT	75	69
% Collectors (g+f)	40	50
% Scrapers + Shredders	60	48
% Hydropsychinae of Trich	50	32
Metals tolerance index	3.20	3.55
Shannon Diversity	3.49	4.12
EPT/Chironomidae	13	4
CTQa	60	64
%Baetidae of Ephemeroptera	15	17
% Coleoptera	18	13
% Diptera	<1	2
% Chironomidae	6	16
% Ephemeroptera	54	50
% Plecoptera	<1	0
% Trichoptera	21	19
% multivoltine	15	22
% univoltine	64	61
% semivoltine	21	17

Functional Feeding Grp.	%RA	# taxa	%RA	# taxa
Filterers	13	2	10	3
Collector-Gatherers	27	16	40	21
Shredders	0	0	0	0
Scrapers	60	8	48	11
Predators	<1	2	1	2

Est. total number of organisms	373	419
Est. number collected per foot	12	14
Est. number collected per minute	373	419

TABLE A. Functional Feeding Groups

Abbreviation	Description
CF	Collector - filterer
CG	Collector - gatherer
OM	Omnivore
PA	Parasite
PR	Predator
SC	Scraper
UN	Unknown
SH	Shredder